DESIGN, SPECIFICATION & ESTIMATE
OF A
REINFORCED CONCRETE & STEEL WAREHOUSE

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The Design, Specifications and Estimate of a

Reinforced Concrete and Steel Warehouse.

A Thesis

Presented by

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To the

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of

Armour Institute of Technology

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Design, Specifications and Estimate of a Concrete and Steel Warehouse.

I N T R O D U C T I O N .

It is the aim of the authors of this work to present the complete economic design of a concrete and steel warehouse. After careful consideration of the four general types of construction, namely (1) Frame construction, (2) Steel construction, (3) Mill or slow burning construction and (4) Reinforced concrete construction, it was decided upon to use a combination of the second and fourth types. The first and third types, not being fireproof, were rejected.

The steel construction alone, although very efficient and durable, is very expensive in first cost, and for this reason is not an economical design for warehouses or factories. The reinforced concrete construction, on account of the reduction in the cost of Portland cement, and also its great fireproof qualities, has become quite a factor in the present design of such buildings as mentioned above. Therefore, the second and fourth types when combined, make a very efficient and economic design. From tests which have been made, and it has also been found in actual experience, concrete will withstand repeated and vibrating loads and this is a condition which designers have long attempted to obtain.

In this design, standard steel shapes are used to aid the concrete where the loads are heavy. In cases where long spans are required steel girders incased in concrete are used.

The Building Ordinances of the City of Chicago have not been stictly followed because the allowed stresses in concrete are lower than those generally used, but instead we

have used methods and values consistent with the latest theories of reinforced concrete and steel design. These theories are based on the results of recent tests and upon structures now in use.

The design of reinforced concrete members has been, and is still a source of great uncertainty as shown by the extensive range of results obtained by the application of the different theories, but as the number of buildings of this type increases, one theory will be found to give better results than some other one, and eventually reinforced concrete structures will be made to give as great satisfaction, and perhaps better, than steel structures.

In this design, a common practice, namely, the use of hooped or spiral reinforcement for columns, has been rejected. According to recent tests it has been found (1) That the bands or hoops do not come into action to any great extent until the concrete has reached the ultimate strength of plain concrete, (2) The amount of shortening in such columns after the hoops are strained is exceedingly great and (3) The lateral deflections are very large. At the same time it is obvious that this system is not economical, as the amount of steel used in hooping is large compared to that used as vertical reinforcement in a column of equal concrete area and carrying capacity.

The design has been governed strictly by the following specifications:-

The ratio between the deformation of the steel and the concrete shall be 15. The steel fiber stress shall in no case exceed one-third the elastic limit of the steel and a maximum fiber stress shall be 20,000# per sq. in. even if this limit is less than one-third the elastic limit.

The stress in the outermost fiber of concrete in beams and slabs composed of 1-2-4 concrete shall not exceed 750# per sq. in. Such concrete, tested in 12" cubes, must show at the

end of twenty-eight (28) days, a strength of not less than 2500# per sq. in. Concrete in columns reinforced with longitudinal rods or bars shall be stressed not to exceed 700# per sq. in. No columns reinforced only with longitudinal rods or bars may contain more than 6% of reinforcement. Columns reinforced with longitudinal rods or bars must have same tied together at intervals not greater than their own thickness apart, with connections not smaller than #10 gauge wire.

No deformed or twisted steel will be allowed to go into the columns as reinforcement.

All concrete, except that used as filler just underneath floors, shall be composed of one part Portland cement, two parts clean coarse sand and four parts broken stone or washed gravel. Cinder concrete to be used as filler underneath maple floors shall be composed of one part Portland cement to seven parts of clean washed and screened cinders with a direct compressive strength of not less than 200# per sq. in.

For one span, slabs shall have a bending moment figured as $Wl^2/8$, for two or three spans $Wl^2/10$, while for anything over three spans $Wl^2/12$. Beams and girders shall never be figured other than freely supported with a bending moment equal to $Wl^2/8$. Panels perfectly square may be considered as having $M=Wl^2/20$, but for panels having one side longer than the other and where the proportion of width to length is less than 1.5, may be calculated according to the following.

Let r = Proportion of load carried on side.
" L = Length of panel.
" B = Breadth of panel.

Then $r = L^4/L^4+B^4$

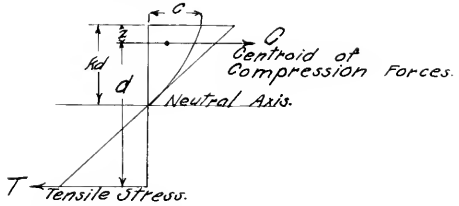
Having found the proportion to go each way, use $Wl^2/12$ to obtain the B.M. In all cases where the bending moment is figured for other than freely supported spand, there must be sufficient reinforcment provided for a reverse B.M. at supports. All beams and girders must be reinforced over supports for negative bending moments. Proper reinforcment for internal and web stresses must be provided in all cases where such stresses may exist.

Beams and girders shall be designed to carry full dead and live loads.

Thirty days after the forms are removed the Superintendent may have the floors, or any portion of them, tested with a load that shall be equal to twice the live load plus the dead load and after said load has been in place twenty four hours the deflection shall not exceed 1/900 of the span.

DESIGN

Resisting Moment of Beams Reinforced on Tension Side Only.



When the Full Compressive Strength of the Concrete is not Developed:- In the figure, "T" represents the total tensile stress in the longitudinal reinforcement, and "C" the total compressive stress in the concrete, considered to be concentrated at the centroid or center of gravity of the compressive stresses. Since these two forces, "T" and "C", are equal, their moment, which is the resisting moment of the beam, is equal to the product of one of the forces and the distance between them. Hence we may write for the resisting moment of the beam;

$$M=Td' = Afd' = pbdfd'.$$

where A represents the area of the longitudinal reinforcement and f the tensile unit stress in the steel. (f = 1/3 the elastic limit of the material.). The quantity d' will vary somewhat with the position of the neutral axis and this position varies with the amount of reinforcement. For light and medium reinforcement and good concrete, an approximate value of d' may be selected which will cover the usual conditions and range of reinforcement with a fair degree of accuracy. For a good quality of limestone concrete, an average value of d' may be taken as .87d. The equation for the resisting moment of the beam then becomes;

$$M = .87Afd = .87pbd^2f.$$

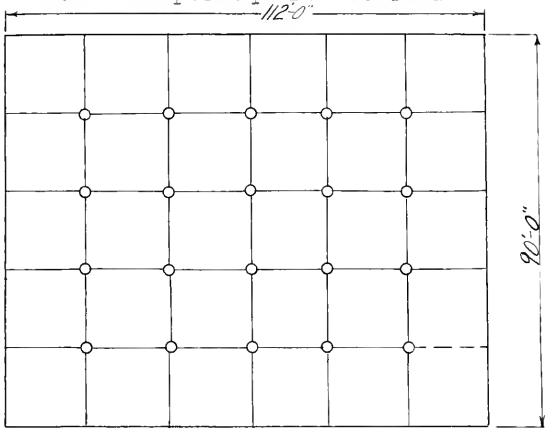
This is a convenient formula for general use.

D E S I G N .

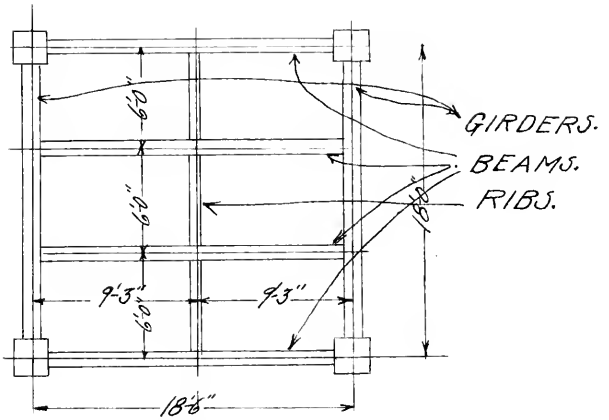
Size of lot----------90 ft. by 112 ft.

Loading:-

225 lbs. per sq. ft. of floor.
50 lbs. per sq. ft. of roof.



Plan of all floors.



Design of slabs on all floors.
Live load to be not less than 125# per sq. ft.
Total load :- 225# per sq. ft.

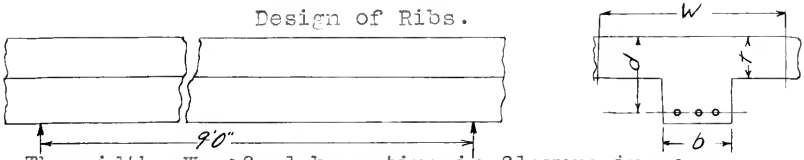
Specifications for the reinforcement:- Three inch mesh #10 gauge double strand Northwestern Expanded Metal having an area of .324 sq. in. per 12" of width and weighing 1.07# per sq. ft.

SPAN		3'6"	4'	4'6"	5'	5'6"	6'	7'	8'	9'	10'	11'	12'
Slab Thickness	Weight per sq. ft.	Superimposed Safe Loads in Pounds Per Sq. Ft											
		1-2-4 Broken Stone or Washed Gravel Concrete.											
3"	37	410	300	230	180	140	110	74	48	30			
3½	43	580	430	330	260	210	170	110	75	50	33	20	
4"	49	820	610	470	380	300	260	170	120	82	57	38	25
4½	55	950	720	550	440	350	290	200	140	97	68	47	30
5"	61		820	630	500	410	330	230	160	110	80	55	37
5½	67		720	710	560	460	370	260	180	130	90	64	43
6	73			790	630	510	410	290	200	140	100	72	47

9 ft. span - 140# live load requires a 6" slab,- dead load = 75# per sq. ft.

Design of beams, slabs, ribs and girders will be the same for all floors, the loading being the same.

Design of Ribs.



The width, W, of slab, acting in flexure in combination with the rib is limited by the following:-

$S\ (1 - S^2/L^2)$, L/3 and 3S/4.

S = distance center to center of ribs = 6 ft.
L = span of ribs between supports = 9 ft.

$S(1 - S^2/L^2) = 6(1 - 36/81) = 3.33$ ft.

L/3 = 2 ft. 3S/4 = 6.5 ft.

Therefore we use 3ft. it being the lowest limit.

$M = .87Afd.$ (1)

A = area of steel required.
S = unit stress in the steel.
d = depth of steel from upper surface.
M = bending moment.

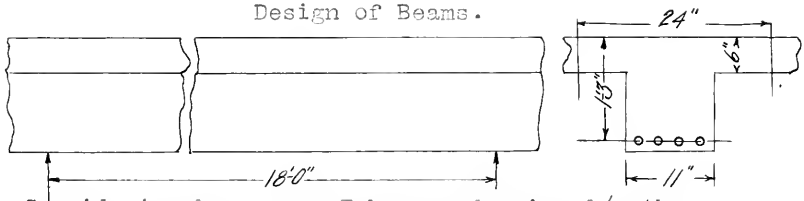
$M = wl^2/8 = 225x3x36x12/8 = 109200$ lbs.

f = 16000 lbs.
Assume d = 8 in. Overall d = 10 in.
Substituting the values of A, f, and d in (1).

$109200 = 16000x8x.87xA$

Then A = .98 sq. in. Therefore use 3---11/16 in. round rods.
This area is less than 1% of inclosed rectangle and therefore according to specifications.

Design of Beams.



Considering beam as a T-beam and using 1/3 the distance between beams as part of beam in compression we have:-

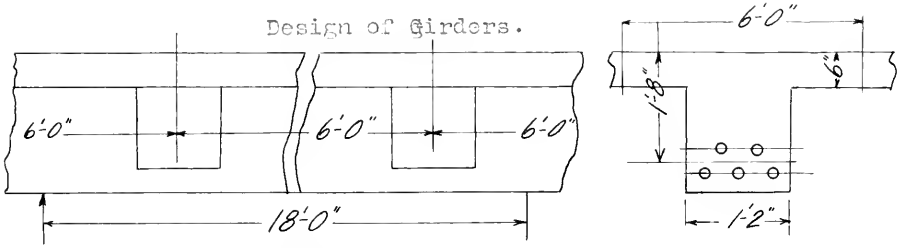
$M = .87Afd.$

But $M = wl^2/8 = 225x6x18x18x12/8 = 656{,}000\#$ in.

Assuming d = 15 in.

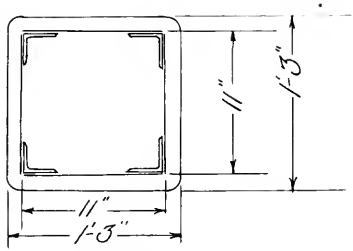
656,100 = .87Ax16000x15.
Therefore A = 3.14 sq. in. equals the amount of steel required.
Use 4----- 1" rods. b = 11"

Design of Girders.

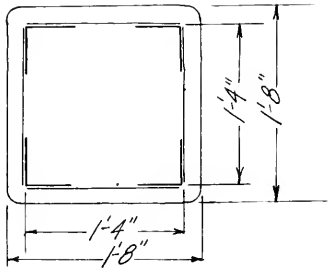


For girders considered as T-beams:-
M = .87Afd.
M = 24,300x6x12 = 1,651,000 in. lbs.
Assuming d = 20 in.
A = 1,651,000/.87x16000x20 = 5.95 sq. in. of steel required.
Therefore use 5-----1.25" round rods.
b = 10"

Design of Columns.



Top Floor:-
Full panel load on each column.
Roof panel load = 18.5x18x50 = 16,650#
Use minimum columns.
Reinforcement----4 angles 3x3x1/4.
Fourth Floor:-
Column load = 18x18.5x885+16650 = 91175#
Use same section as above.
Area of steel required = 5.76 sq. in.
Stress taken by steel = 7000x5.76= 40,320
" " " concrete = 600x121 = 72,600
Total 112,920



Third Floor:-

Column load = 18x18.5x225+215775 = 166,400#

Use 4 angles 4.5x4.5x7/16

Therefore area of steel = 13.24 sq. in.

Stress taken by steel = 7000x13.24= 92,680#

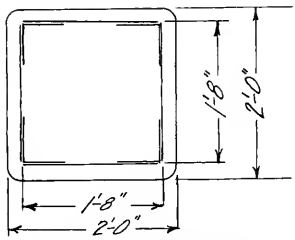
" " " concrete = 600x256 =153,280#

Total 246,280#

Second Floor:-

Column load = 18x18.5x225+166400 = 241415#

Use same section as above.



First Floor:-

Column load = 18x18.5x225+241415 = 316340#

Use 4 angles 4x4x5/8

Therefore area of steel = 18.44 sq. in.

Stress taken by steel = 18.44x7000 = 129,200#

" " " concrete = 441x600 = 264,600#

Total 393,800#

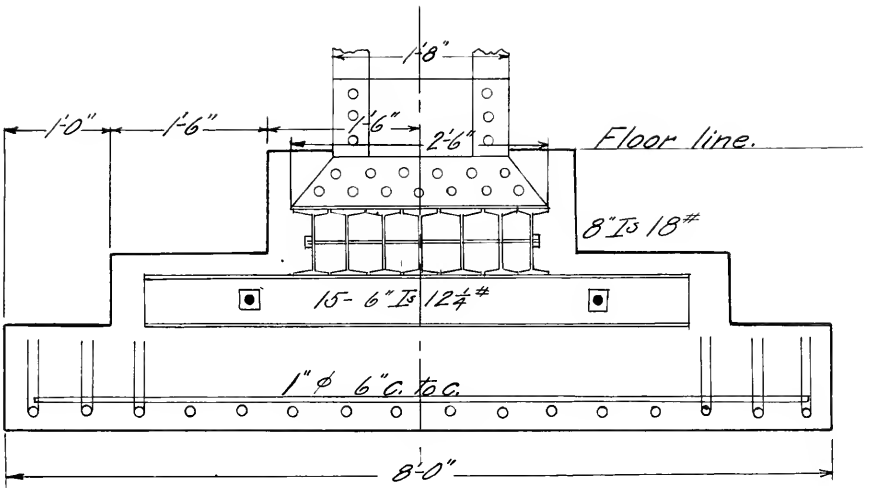
Basement:-

Column load = 18x18.5x225+316340 = 391265#

Use same section as above.

Column Footings.

Foundation in moderately wet clay.
Bearing value allowed---- 4 tons per sq. ft.
Bearing load on each inside footing.will equal
391,265+(wt. of col.= 25,000) = 416,265#
416,265/8,000 = 52.032
Use footings 8'x8' Section as follows.



SPECIFICATIONS

E X C A V A T I O N.

The finished lines of excavations are to conform as nearly as possible to the lines of the concrete, leaving only such spaces as are required for pointing the walls. Where plank forms are not required trenches for footings must be cut to the exact size of the concrete. Any excavations made to a greater depth than that required must be filled with concrete, as under no circumstances shall such spaces be backfilled with earth. All wood form must be removed, but not until the concrete has set.

Any backfilling done before it is ordered, or any earth caving against foundations must be removed. All backfilling shall be done with approved clean earth puddled or tamped to the required grades.

If any old excavations within 5'0" of footing extend below same, directions for filling must be obtained from the Supervising Architect before proceeding with the work.

Any piping encountered shall be removed to a point 1'0" outside foundations and capped or plugged tight unless otherwise specified or directed.

C E M E N T.

All Portland cement shall have a specific gravity of not less than 3.1. It shall contain not more than 1.75% anhydrous sulphuric acid (SO_3) nor more than 3% magnesia(MgO).

The standard of fineness shall be that 92% by weight shall pass a 100 mesh sieve and 75% shall pass a 200 mesh sieve. If the material does not meet these requirements as to fineness, it will either be rejected or the contractor will be required to use 2% additional for each 1% drop below the 92% limit, or 3% additional for each 1% drop below the 75% limit.

It shall develop initial set in less than 30 minutes, and a hard set in not less than one or more than 10 huors.

Pats of neat cement about 3" in diameter 1/2" thick at center and tapering to a thin edge, shall be kept in moist air for 24 hours. Should these pats not remain firm and hard, or should they show signs of distortion, blotches, discoleration, checking, cracking, or disintigration after being exposed to the air at normal temperature for seven days, or after being kept in water at 70 degrees F. for seven days, or after exposure in a steam bath in a closed vessel for five hours, the material will be rejected.

Non-staining cement shall be of a brand that has been in use for at least two years to test its non-staining qualities. It shall have a specific gravity of not less than 2.95 and in all other respects conform to the above requirements for Portland cement.

All cement shall be delivered in the original packages, bearing the brand and name of the manufacturer and must be kept dry.

CONCRETE AND MORTARS.

SAND AND AGGREGATE.

Sand shall be clean, sharp and coarse.

Broken stone and gravel shall be clean, hard and durable and so broken that the largest pieces shall not exceed the sizes specified.

Aggregate for footings shall be broken so as to pass through a 2" mesh screen and all other aggregate shall be broken to pass through a 3/4" mesh screen.

Clinkers shall be thoroughly vitrified and shall be free from dirt, ash unburned coal, or other deleterious matter.

MORTARS.

All surfaces of sandstone or limestone in contact with masonry shall be completely covered with mortar composed of one volume of non-staining cement and two volumes of sand, and all pointing of such stonework shall be done with the same kind of mortar. All other mortar, unless otherwise specified, shall be composed of one volume of Portland cement and three volumes of sand. The cement and sand must be mixed dry until the cement is so thoroughly distributed that no particles of sand can be detected; and then only enough water added to bring it to a plastic condition after being thoroughly worked.

Mortar remaining unused at the time initial set occurs shall not be used in the work, and the cement and sand shall not be mixed more than one hour before the water is added. No mortar or concrete shall be used in freezing weather.

CONCRETE.

The cement and sand shall be made into mortar as above specified, the aggregate drenched, drained and mixed with the mortar until each piece is thoroughly coated, and immediately placed in position in continuous layers and tamped until water appears on the surface. All concrete shall be protected from the sun and be kept wet at least 48 hours.

FOOTINGS.

The concrete for footings (except column footings) shall be composed of one volume of Portland cement, three volumes of sand and six volumes of broken stone or gravel. Where the earth will not stand, plank forms must be employed which shall be rigid and of sufficient size to permit the concrete to be of the required dimensions. Concrete for column footings shall be composed of one volume of Portland cement two volumes of sand and four volumes of broken stone or gravel.

REENFORCED CONCRETE.

The concrete for slab over coal area, stack coping, steps, stairs, and platforms, ceilings and walls, and concrete lintels and floor construction where noted shall be composed of one volume of Portland cement, two volumes of sand and four volumes of broken stone. Other reenforced concrete hereinafter specified, shall be similar, but the aggregate shall be be cinders or oyher approved light mateial. Exposed surfaces of concrte not to be plastered, shall be finished smooth.

All beams and girders in connection with construction(except plate girders) shall be entirely encased in concrete,which must nowhere be less than 2" thick. The concrete under soffits must be placed entirely from one side and tamped until it is forced through on the pther side.

Metal fabric for the reenforcement of concrete slabs shall be #10 expanded metal,3" mesh or electrically welded or lock woven galvanized wire fabric of #8 wire (4" on centers) and #10 wire (6" on centers) or other approved metal of equivalent strenghh. Metal which is not galvanized shall be free from rust when placed in the concrete.

Reenforcement of all horizontal and inclined concrete shall be uniformly placed so as to be distant from the bottom of the concrete not more than 3/4" except over beams. Metal which is bent in laying so as to materially depart from the proper position will be rejected. All reenforced concrete shall be laid continuously with the long axis at right angles to bearings,lapped at least one mesh at joints and strongly wired together. Metal loops in concrete in connection with beams and girders must be kept at least 3/4" away from the soffits of the beam.

In walls, the reenforcing metal should be placed approximately in the center of the concrete.

Forms and centers must be so constructed and secured that there will be no deflection or vibration and they must not be struck until fif-

teen days after placing the concrete.

WINDOW SILLS.

The concrete for sills shall be composed of one volume of Portland cement, two volumes of sand and four volumes of broken stone. The reenforcing metal shall be #16 gauge, 2" mesh and bent to form indicated. All sills shall have cement finish.

TESTS.

Before any filling is done the reenforced concrete floors must be tested by the contractor, where directed, by placing 8000# dead load, evenly distibuted over 10 sq. ft. of surface, after thoroughly shoring the steel beams. Any work damaged by such tests will be rejected, and should two failures occur, further instructions must be obtained from the Supervising Architect before proceeding with the work.

CEMENT FINISH.

All concrete having cement finish shall have a coat at least 1" thick composed of two volumes of Portland cement and three volumes of sand, with only enough water to make a stiff mortar. The finish coat must be applied before the concrete base commences to set and be troweled to a smooth even finish. Dry cement must not be used on the finished surface.

All openings between rooms having cement floors, except opening to fuel room, shall have 1/2" high cement thresholds with beveled edges, formed at the time of laying the cement finish.

FILLING.

The aggregate for filling over floor construction shall be 3/4" cinder or other approved light material. Just before any filling is done the concrete must be swept clean, drenched, and

STEEL AND IRON WORKS.

QUALITY OF STEEL.

All strucural steel must be of medium steel of uniform quality, finished straight and smooth, free from defects, the full weight called for and shall have an ultimate strength of from 60000# to 68000# to the sq. inch; elastic limit not less than 1/2 the tensile strength, minimum elongation of 22% in 8 inches of length, minimum reduction of area at fracture of 40%, and to bend cold through 180 degrees on a diameter equal to the thickness of the test piece, without showing a crack or flaw on the outside of the test piece.

Rivet steel to have a tensile strength of 50000# to 53000# to the sq. in; and an elastic limit of not less than 1/2 the tensile strength, a reduction in area at fracture of at least 50% and an elongation of 26% in 8". Rivets must be capable of being bent cold on themselves and flatened without showing any signs of fracture.

All steel must be free from rust.

WROUGHT IRON.

Wrought iron must be tough, fibrous, uniform in character and of perfect manufacture.

CAST IRON.

All the castings to be of tough, gray iron, free from cold shuts or blow holes, true to pattern and of workmanlike finish.

covered1/16" thick with neat Portland cement. Concrete for filling shall be composed of one volume of Portland cement,three volumes of sand and seven volumes of aggregate.

Finish under wooden floors must be finished level with tops of wooden strips. Filling under terrazzo shall be of same composition as is required for reenforced cinder concrete floors; 3/4" from bottom of the concrete place 2" mesh and #13 gauge expanded metal or other material of metal fabric of equal strength.

Sample pieces of structural cast iron one inch square, cast from the same heat of metal in sand moulds, must be capable of sustaining on a clear span of 4'8" a central load of 500#. A blow from a hammer shall produce an indentation on a rectangular edge without flaking the metal.

Ornamental iron shall be cast from iron suitable from the finest quality of castings.

WORKMANSHIP.

All workmanship shall be of such character that the connections shall be of equal strength and durability as the plain portions between them. They are to be riveted where practicable, where not, bolts may be used, the nuts to be drawn up tight and the ends of the bolts to be upset. All joints in compression must give close bearing throughout. Built members must be free from twists or open joints. The diameter for the punch for rivet holes shall not exceed that of the rivet by more than 1/16", and all holes shall be clean cut, without ragged or torn edges. Holes must be spaced so accurately that when the parts are assembled the hot rivets will enter without being distorted and shall completely fill the holes after being upset.

Where holes need enlarging it shall be done by reaming. If it is necessary to use bolts, the holes must be the exact size of the bolts. Rivets shall have standard heads concentric with the shafts, with full bearing on the surface. Drift pins must not be used to distort the metal around the holes in assembling the work.

The thickness of the various parts of each casting shall be practically the

same,and no structural castings are to be taken from the sand until cool. All castings shall be clean,have sharp outlines, and all surfaces adjoining steel or iron shall be planed.

INSPECTION.

As soon as practicable after the award of the contract, the Supervising Achitect must be notified where the work is to be made up,so arrangements may be made for inspection and ample facilities must at all times be furnished and at least three days notice given to the authorized agents of the owners, for making such inspection of materials and workmanship as may be desired; and no part of the work shall be painted,or shipped, before the materials have been inspected or written notice received from the Supervising Architect that inspection will not be made. Should material be shipped without being inspected or notice given that inspection will not be required, the cost of extra inspection will be deducted from any money due the contractor.

SETTING.

All steel and iron work must be accurately set and substantially secured in place as the work progresses. The contractor will not be permitted to proceed with the concrete construction leaving holes into which to install steel later. Steel ~~pa~~es plates are to be used for leveling wherever steel construction rests on the concrete and shall be bedded as hereinafter specified. Cast iron bases under columns shall be set level and have space below grouted with neat Portland cement.

ANCHORS.

Anchors for iron or steel work in connection with the concrete shall be built in as

the work progresses.

PIPE RAILING.

Pipe railing shall be of galvanized standard wrought iron or mild steel pipe with galvanized malleable fittings, the fittings to be cast to the proper angles of the work required. The pipe shall be threaded and screwed into the fittings. The fittings shall have large flanges and be secured to the concrete with at least 3/8" expansion bolts, three to each flange. The dimensions given are inside dimensions.

THRESHOLDS.

Metal thresholds shall have channeled or checkered pattern on the upper surface to within 3" of the frames. Thresholds in connection with the sliding doors shall be at least 6" longer at each end than the width of the opening, and the ends shall have lugs cast on to form guides for sliding doors. All metal thresholds shall be secured in place with countersunk expansion bolts, or screws, as may be required, two at each end and intermediate ones spaced not over 12" apart.

STAIRS.

Cast iron casings of concrete stringers and cast iron newell shall not be less than 5/16" thick. Castings shall have stiffening webs not over 2'0" apart staggered. Wrought iron verticals of stairs railing from 1st to 2nd floor to be shouldered and headed to top and bottom rails; bottom rail to be secured to cast iron stringer casing with tap screws spaced not over 18" apart, thickness of casing to be increased at points where tap screws are placed.

LAMPS.

The lamps in vestibule shall be of cast iron. All joints shall be fitted close and lamps are to be fitted securely to the framing. Drill

holes on all sides of the metal flanges below the globes so that sufficient air can enter if it is desired to burn gas. The globes shall be translucent opelescent glass with proper openings for admission of a 50c.p. lamp, and secured with at least three base screws.

The standard must be piped for gas and wired with #14 , rubber insulated,copper conductor in strict accordance with the " National Electric Code ", and connected to the gas piping and wiring of the building. The gas pipe in each globe to be capped with an insulating joint and the wiring connected to Edison base porcelain sockets mounted on the insulating joints so that the center of a 50 c. p. lamp bulb will be in the center of each globe.

Approved gas burners to be supplied but not connected.

ORNAMENTAL IRON.

Ornamental wrought iron shall be forged and finished by hand. All turns shall be forged with sharp angles. All loops,rings etc., shall be without visible joints; curves shall be true and size of members where not given shall be sufficient for strong work,and all joints in ornamental iron work shall be of such a character that they will be as strong and rigid as adjoining sections. Members in contact, not otherwise indicated,shall be welded but where welding is not practicable,they shall be riveted.

PAINTING AND FINISHING OF IRON WORK.

All anchors,cramps,etc., in connection with masonry shall be either galvanized or heavily coated with ashphalt. All steel and iron work of every

description,before leaving the shop, shall be cleaned of scale,rust,etc.,and except as above specified, given a coat of paint.

All paint for structural steel and iron as above referred to,shall be a graphite paint. The pigment of the paint shall have at least 40% of graphite carbon and the paint must not contain rosin or petroleum products.

All exterior iron work shall be given one coat of the above paint and then finished as hereinafter specified.

All interior iron work shall be given one coat of boiled linseed oil and finished as hereinafter specified.

All material for painting must be delivered in the original packages,with seals unbrocken.

All paint shall be kept well stirred while being used and must be well rubbed on with brush. All work shall be clean and dry while being painted, and each coat shall be dry before the next coat is applied. Whenever,on iron or steel the appears to have separated or run, the painting will be rejected.

PAINTING AND POLISHING,

PAINTING.

All exterior wood work shall be given in addition to any previous painting, three coats of white lead paint, and all exterior iron work shall be given in addition to any previous painting two coats of white lead and oil paint, the iron to be finished flat.

All finishing wood in contact with concrete or plastering shall have a heavy coat of metallic paint on the back.

Puttying must be done after priming, with white lead putty.

All tin and galvanized iron work on the exterior of the building shall be given one coat of paint composed of one gallon of oil to 15 lbs. of red lead and two additional coats of same paint containing enough lamp black to color the paint a very light brown.

VARNISHING.

Hardwood shall be carefully filled a warm dark brown tint, the inside of exterior sash stained to match and all given three coats of varnish to be rubbed down with steel wool or curled hair and the last coat rubbed down with pumice stone and oil and wiped to a dead finish. All other interior woodwork shall be given a coat of shellac and two coats of varnish, each coat except the last to be rubbed down.

OILING.

When all other work is completed, the wood floors, except maple floors, are to given a coat of raw linseed oil with sufficient stain to give the desired tint, and then finished with a coat of boiled linseed oil.

WORKMANSHIP.

All work must be thoroughly cleaned, sand papered and painted or filled as soon as practicable after being made up. No subsequent coat of oil or v varnish shall be applied or rubbing done until the previous coat is thoroughly dry. All coats of paint must be thoroughly brushed out.

MATERIALS.

White lead shall contain not less than 70% carbonate of lead to 30% hydroxide, nor more than 75% carbonate of lead to 25% hydroxide.

Varnish shall contain not less than 25% of imported vegetable gum and be free from rosin or petoleum products. The film after the varnish is dry must be hard, tough, and elastic. Varnish must not be thinned in any manner.

SHELLAC.

Shellac shall be of gum and pure grain alcohol.

Dryer shall contain no rosin.

Oils shall be puer linseed without "foots".

Putty except for glazing shall be composed of white lead paste mixed with dry white lead until of the proper consistency.

The putty shall be colored to match the paint.

P L A S T E R I N G.

LATHING.

[illegible] lathing shall be of "[illegible]" wire cloth 3/8" mesh stiffened about every 7" with [illegible] of 3/16" dia. or with other metal stiffeners of approved design not less than "[illegible]" gauge.

INTERIOR PLASTERING.

All plastering in finished rooms shall be three coat work, except that the finish coat may be omitted [illegible] wainscoting. The finish coat shall be [illegible] white coat, trowelled smooth, except where otherwise specified.

All plastering, except as otherwise specified, including finish coat, shall be done with a standard brand of hard plaster, which must be mixed by the manufacturer either dry or as prepared ready for application with the addition of the necessary amount of water and under no circumstances will the contractor be permitted to add any solid material. The plaster must be of such nature that under any condition the finish coat may be applied within [illegible] days from the laying of the first coat without any detriment to any portion of the work.

The plaster must be applied in accordance with the specifications of the company supplying the same, unless it conflicts with the requirements herein, and the finish work must be equal to the best it is possible to obtain with the use of any hard plaster.

All walls and ceilings must be swept clean and the concrete wet before plastering.

W I R I N G.

No vault protection telephone, clock or bell wires are included in this contract.

The wiring for the lighting system must be installed complete from the service box to all outlets indicated on the drawings.

Feeders from the service box to distibution tablets are to consist of three conductors, the neutral to have a cross sectional area equal to the combined cross section of the two outside conductors.

Branch circuits are to be two wire with both conductors in the same conduit.

All sizes are to be Brown and Sharp gauge and no wire smaller than #14 to be used.

Conductors inside the building must be rubber covered, double braid copper of highest conductivety, made in strict accordance with the " National Code" and must have a distinctive mark of the maker.

No splices or joints will be permitted in either feeders or branches, except at outlets, and there they must first be made mechanically and electrically secure, then soldered and taped with one layer of rubber and one of friction tape.

The entire wiring system must test free from short circuits and grounds, and have an insulation resistance between conductors and ground, based on maximum local, not less than the requirments of the latest edition of the "National Electrical Code".

All electrical wiring to be pulled in approved iron conduit and no conduit smaller than 1/2" shall be used. All conduit must be properly

reamed and securely fastened in boxes with lock nuts and bushings. Entire conduit system to be thoroughly grounded.

All ceiling outlets shall be counted as clusters and not more than three outlets to a circuit shall be allowed. Each outlet to be switched seperate from floor cutout boxes.zCeiling outlets must be put in round iron boxes 4" in diameter and at least 1.5" deep, to come flush with face of finished ceiling.

Main switchboard shall be located in basement where shown on plans and must be made of slate with double throw knife switches throughout, fused for incased cartridge fuses. It shall be equipped for both local and house service. All power and light switches to be designated with brass plates. Floor service boxes to be located where shown on plans, to be in approved iron boxes set flush with finished walls and have proper catch and handle and to be tagged with metal tag. Each floor box to have circuit fuse blocks and switches on one porcelain block. Switches to be single pole snap switches. All fuse blocks shall be for three wire service.

All inspection must be taken care of by the contractor and inspection fees paid. Work will not be considered complete until inspection certificate has been turned over.

Down spouts shall be [illegible] heavy [illegible]. Goosenecks shall be riveted and soldered to the gutter. At the bottom they shall extend [illegible] 3" [illegible]. Down spouts shall be secured by [illegible] hangers [illegible] and expansion [illegible].

PAINTING.

All parts of [illegible] galvanized iron work on the exterior of the building [illegible] shall [illegible] be cleaned of all grease, [illegible] etc., [illegible] gallon of [illegible] oil.

All exposed copper shall be oxidized.

WOOD WORK.

FRAMING.

All framing lumber shall be thoroughly seasoned hard pine, free from defects that will impair strength.

FLOORING.

Flooring [illegible] be of 7/8" [illegible] 3-1/4" [illegible] on 1-5/8" nailing strips 12" center to center, [illegible] heretofore stated.

DOOR FRAMES.

Exterior door frames shall be 2-1/4" thick, interior door frames shall be 1-7/8" thick, except that frames for double acting doors shall be thick enough to form fillets for hanging the doors from the [illegible], so the nailing or [illegible] will not be [illegible]. The frames [illegible] the masonry [illegible] be concealed by other finish.

DOORS.

Exterior doors shall be [illegible] thick. Interior doors shall be [illegible]/4" thick. Fly doors shall be 1-1/4" thick.

WINDOW FRAMES.

Pulley stiles [illegible] box [illegible] shall be [illegible] pine. [illegible] the pulley stiles shall be [illegible] and the pocket pieces shall be [illegible] with [illegible] [illegible] tightly fit [illegible]. [illegible] in the [illegible] shall be [illegible] with [illegible] washers.

the strips can be [illegible].

Frames for hinged sash shall be 1-3/4" thick and rebated. Sills of all wood window frames shall be 2-1/4" thick and plowed to fit the lip of concrete sill.

Frames in all concrete walls shall be built in [illegible]. The frames shall be anchored to the cement with holdfasts of galvanized iron not over 3 feet apart.

CAULKING.

All exterior door and window frames shall be tightly caulked with oakum from both sides before the boards are permanently secured in place, and the work must be guaranteed for two years, and should the walls beside the openings become in any way discolored during that period, the contractor must recaulk until satisfactory.

SASH.

All sash shall be 1-3/4" thick, except that sash over doors shall be the same thickness as the doors. All sash shall be mortised and tenoned together: exterior sash to be pinned, and interior sash to be wedged and glued. Exterior hinged and fixed sash shall have drips.

HAND RAIL.

Wood hand rails shall be of quarter sawed oak rail secured to the [illegible] with screws from the underside, joints to be made with concealed stair rail bolts.

WAINSCOTTING.

Wainscotting shall be of 7/8" by 3-1/4" matched and V-jointed, each piece to be driven close and blind nailed with [illegible] nails

E S T I M A T E

Contr. | do | Shop No.

Date May 20-1909 | Set or Frt. | Let

Mark	No.	Articles	Sizes	Wt. 1 Pc.	Cast Iron		Beams			Sundries
					Plain	Special	Punched	P. and Coped	Bolts, Anchors, Etc.	
		Sidewalk	16'-0"							
	13	18 I's 55#	17'-10"	880			11440			
	5	15 I's 42#	18'-4"	750			3750			
	4	15 I's 42#	18'-10"	770			3080			
	2	15 I's 42#		790			1580			
		34 Column Footings								
		7-8" I's-18#	2'-6"	314						
		15-6" I's-12.25#	5'-6"	1483						
		2-1" tie rods	2'-4"	6						
		2-1" " "	3'-2"	8	1811		61574			
		7 Column Footings								
		7-8" I's-18#								
		10-6" I's-12.25#		314						
		2-1" tie rods		990						
		2-1" " "		6						
				7	1317		9219			
		Basement & 1st Story Columns								
	20	4-Ls-4x4x5/8	25'-0"	1570						
		16-Ls-3x3x5/8	1'-8"	311						
		2-Ls-6x6x5/8	2'-9"	133						
		2-Ls-6x6x5/8	1'-8"	85						
		56 Pl. 3"x1/2"	1'-8"	448						
		108-3/4 Rivels		54						
		1-Pl.-33x1/2	2'-9"	154	2755		55100			
		2nd & 3rd Story Col								
	20	4-Ls-4"x4"x7/16"	25'-0"	1130						
		16-Ls-3"x3"x5/8"	1'-4"	247						
		56-Pl 3"x1/2"	1'-4"	392						
		80-3/4" Rivets		40	1909		38180			
		4th & 5th Story Col.								
	20	4-Ls-3"x3"x1/4"	25'-0"	490						
		16-Ls-3"x3"x1/4"	1'-4"	80						
		56-Pl-3"x3/8"	1'-4"	280						
		80-3/4" Rivets		40	890		17800			
		Basement & 1st Story Wall Col								
	19	4-Ls-4"x4"x5/8"	25'-0"	1570						
		12-Ls-3"x3"x5/8"	1'-8"	230						
		2-Ls-6"x6"x5/8"	5'-0"	242						
		2-Ls-6"x6"x5/8"	1'-8"	81						
		28-Pl-3"x1/2"	4'-6"	643						
		28-Pl-3"x1/2"	1'-8"	252						
		1-Pl-33"x1/2"	5'-0"	281						
		108-3/4"-Rivets		54	3353		63707			
	2	4-Ls-4"x4"x5/8"	12'-0"	754						
		12-Ls-3"x3"x5/8"	1'-8"	230						
		2-Ls-6"x6"x5/8"	5'-0"	242						
		2-Ls-6"x6"x5/8"	1'-8"	81						
		28-Pl-3"x1/2"	4'-6"	643	1950		3900			
							269330			

Contr. | do | Shop No.

Date May-20-1909 | Set or Frt. | Let

Mark	No.	Articles	Sizes	Wt. 1 Pc.	Cast Iron: Plain	Cast Iron: Special	Beams: Punched	Beams: P. and Coped	Beams: Bolts, Anchors, Etc.	Sundries
	2	28-Pl - 3"x½"	1'-8"	252						
		1-Pl - 33"x½"	4'-6"	252						
		68 Rivets		34	538		1076			
		2nd & 3rd Story Wall Col.								
	21	4-Ls-4"x4"x 7/16"	25'-0"	1130						
		8-Ls-3"x3"x 5/16"	1'-4"	124						
		4-Ls-3"x3"x 5/8"	3'-6"	164						
		28-Pl.-3"x½"	3'-6"	476						
		28-Pl.-3"x½"	1'-4"	198						
		80-Rivets		40	2132		44772			
		4th & 5th Story Wall Col.								
	21	4-Ls-3"x3"x½"	25'-0"	490						
		8-Ls-3"x3"x¼"	2'-6"	98						
		4-Ls-3"x3"x¼"	0'-11"	20						
		28-Pl-3"x 3/8"	2'-6"	364						
		28-Pl-3"x 3/8"	0'-11"	140						
		80-Rivets		40	1152		24192			
		Plate Girder.								
	1	2-Pl-22"x½"	37'-0"	2768						
		2-"-22"x½"	21'-0"	1570						
		2-"-36"x½"	37'-0"	4538						
		2-"-17"x½"	1'-10"	108						
		1-"-13½"x½"	1'-0"	23						
		4-Ls-4"x4"x 5/8"	37'-0"	2324						
		32-Ls-4"x4"x 5/8"	2'-10½"	1476						
		4-Ls-4"x4"x 5/8"	1'-1½"	34	12841		12841			
		2-Cast Iron Col - 1"-Metal.				9004				
	2			4502						
		Cast Iron base plates.								
		24"x34"-1" Metal.		245		490				
		Plain Reinforcement								Rods
	865	1¼" Round Rods	24'-0"	100						86500
	1996	1" " "	24'-0"	64						127744
	426	11/16" " "	24'-0"	30						12780
					9494		82881			227024

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Quantities by Extended by Checked by

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Quantities by Extended by Checked by

Marks	Sheet No.	Items	Weights	Total Weights	Rates	Total Amounts
	1	Sidewalk Is		19850	2½	$496 25
	1	Column Footings	1811	61574	2½	1539 35
		" "	1317	9219	2½	229 50
	1	Columns				
	1	Basement & 1st Story	2755	55100	3½	1928 50
	1	2nd & 3rd "	1909	38180	3½	1340 35
	1	4th & 5th "	890	17800	3½	623 00
	1	Basement & 1st Story Wall Col.	3353	63707	3½	2229 75
	1		2488	4976	3½	174 15
	2	2nd & 3rd " " "	2132	44772	3½	1567 00
	2	4th & 5th " " "	1152	24192	3½	866 75
		Plate Girder	12841	12841	3½	449 45
	2	Cast Iron Cols.	4747	9494	1½	142 40
	2	Plain rods		227024	1.7	3859 30
		Expanded Metal		$.04 per sq ft		377 30
		Setting up	35 tons at $10 per ton			350 00
		" "	129 " " $20 " "			2580 00
		Total cost of Steel & Cast Iron				$18753 05
		Concrete				
		Volume of concrete for floors in yds.		1370		
		" " " " walls " "		1210		
		" " " " columns " "		655		
		" " " " footings " "		180		
			Total	3415	6.00	$20490 00
		Total estimate for concrete and Steel.-				$39243 00

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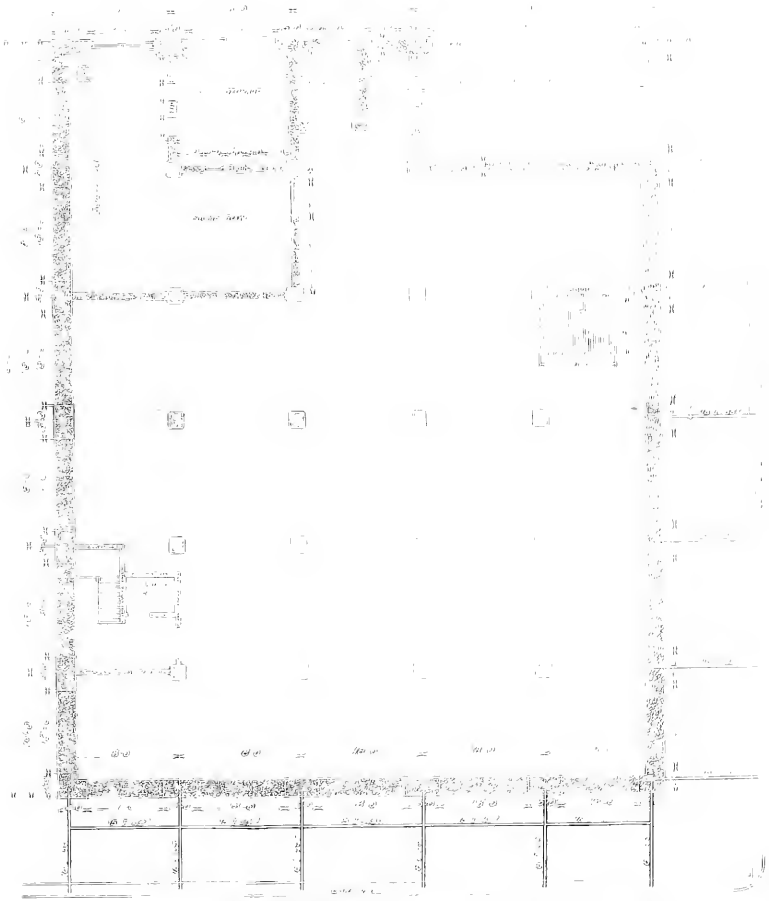
FOUNDATION PLAN



BASEMENT PLAN

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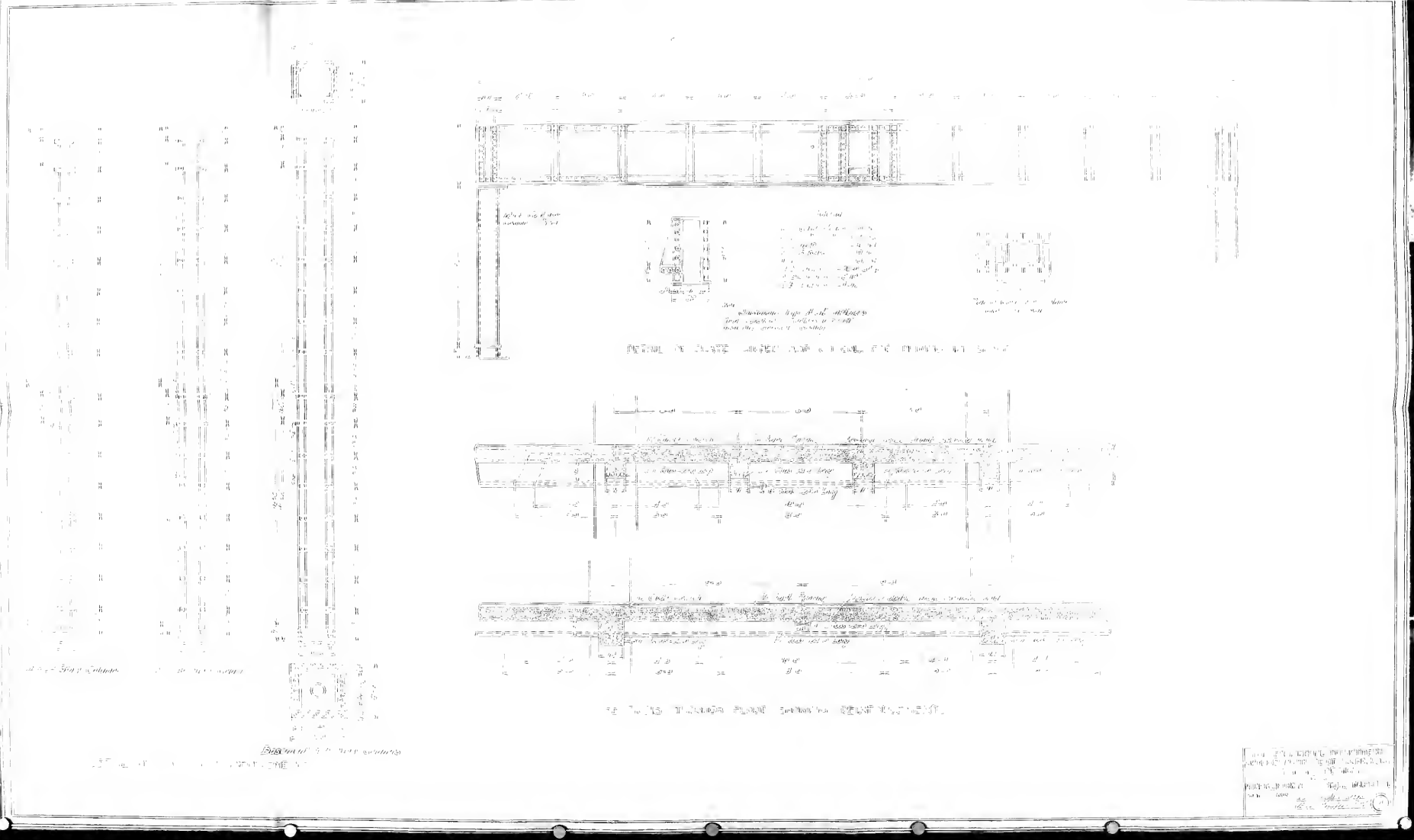

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